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None

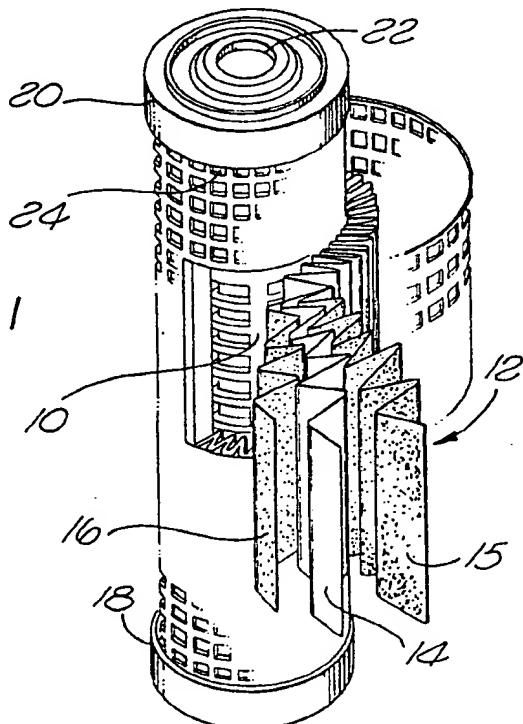
(58) Field of search

B1D
B1T

(54) Filter element

(57) A filter element is constructed so that all surfaces thereof which are exposed to the filtrant are constructed of a fluorocarbon resin. The filter element includes a core member (10) over which there is disposed a filter media (12), the end edges of which are bonded to a pair of end caps (18, 20) which include metallic means embedded therein. An outer protective sleeve (24) may be incorporated to protect the filter media from potential damage. The filter media includes a membrane (14) and a screen (16) laminated together. The metallic means, which may be a solid or perforated disc, or metal particles, enables induction heating to be used to fuse the fluorocarbon resin of the end caps (18, 20).

FIG. 1



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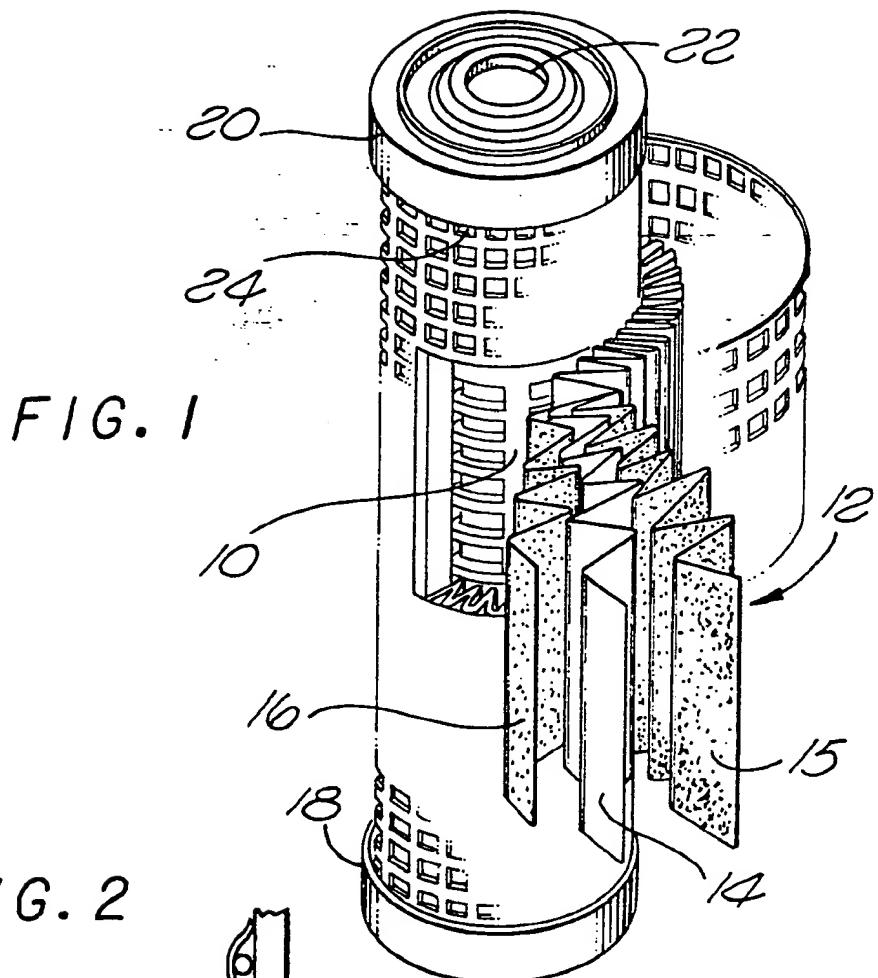
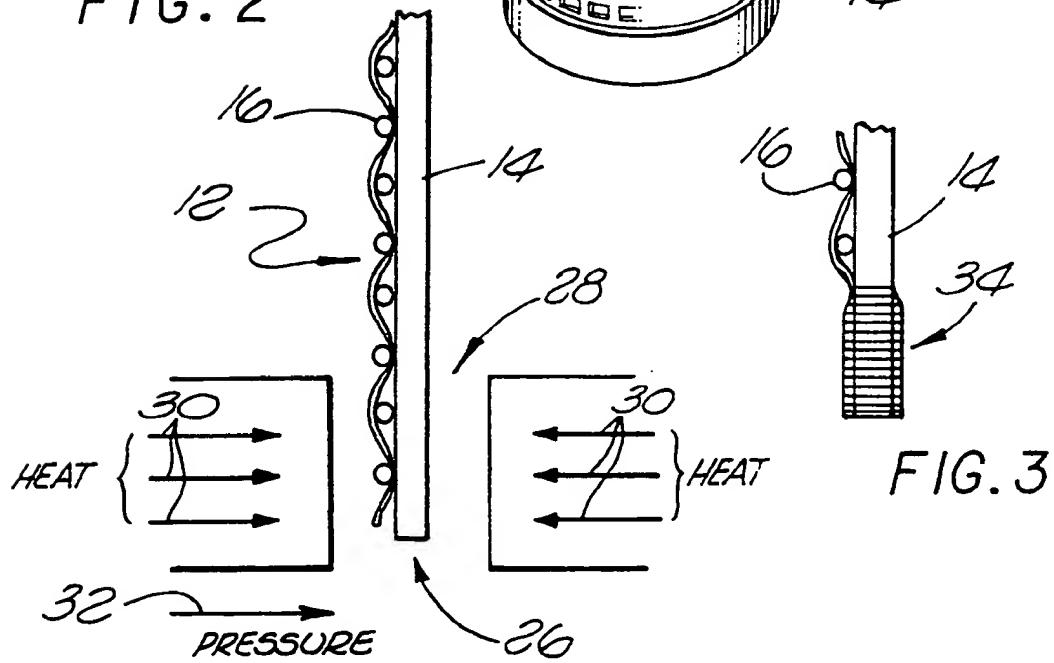
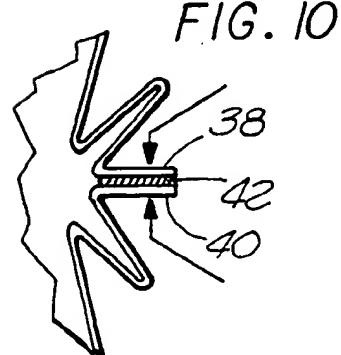
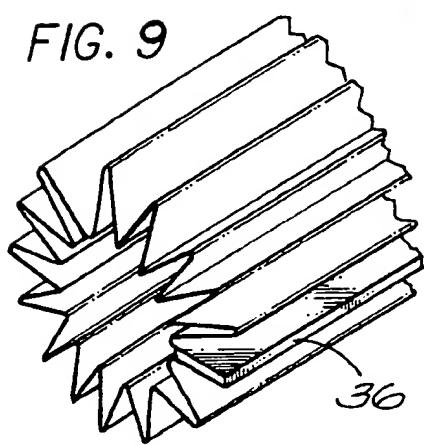
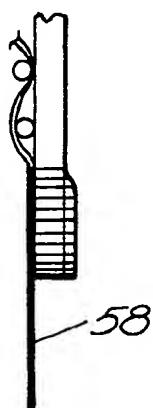
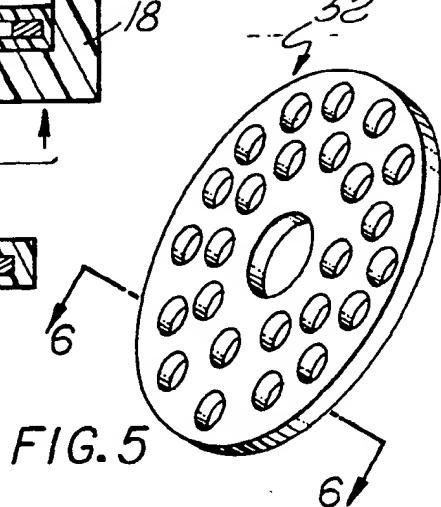
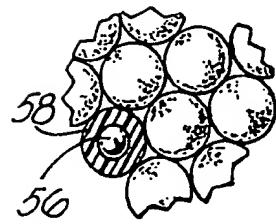
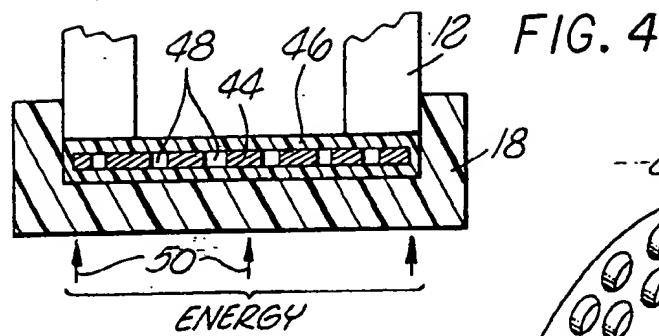


FIG. 2



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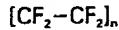
SPECIFICATION**Filter element****5 Background of the invention**

In many manufacturing processes it has been found desirable to utilize filter elements in the presence of highly reactive chemicals such as sulfuric acid, nitric acid, chromic acid, hydrochloric acid, hydrofluoric acid, sodium hypochlorite and the like, sometimes at relatively high temperatures. Such highly reactive chemicals attack most known prior art filter elements, particularly those utilizing solvents or adhesives in the manufacture of the elements. As a result, the prior art filter elements either cannot be used or have a relatively short lifetime and must be replaced fairly frequently, thus adding to the cost of the manufacturing process.

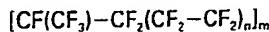
20 Fluorocarbon resins have unique combinations of physical and chemical properties which make them particularly useful in such hostile environments as those of filtering reactive chemicals even at high temperatures.

25 Various efforts have been made to construct filter elements using fluorocarbon resins which will withstand such highly reactive chemicals and the best known art is represented by U.S. Patent 3,457,339, 2,732,031, 2,771,156, 2,934,791, 2,941,620, 3,013,607 and 4,184,966. However, to applicant's knowledge, the prior art has not been successful in constructing a filter element in which all surfaces thereof which are exposed to the filtrant is constructed of a fluorocarbon resin.

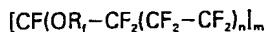
35 By the term "fluorocarbon resin" as used throughout the specification and claims it is meant a polymer wherein a carbon atom has adhered thereto atoms of fluorine. Typical examples of such fluorocarbon resins is a polymer consisting of recurring tetrafluoroethylene monomer units whose formula is:



commonly referred to as "TFE"; a copolymer of tetrafluoroethylene and hexafluoropropylene with the formula:



50 commonly referred to as "FEP"; and a copolymer of tetrafluoroethylene and perfluorinated vinyl ether having the formula:



55 commonly referred to as PFA.

Summary of the invention

A filter element constructed of a fluorocarbon resin which includes a fluorocarbon resin perforate core member having positioned thereover a fluorocarbon resin filter media including a fluorocarbon resin membrane. The end edges of the fluorocarbon resin filter media are bonded to a pair of end caps each of which includes metallic means

embedded therein adjacent the end edges of the filter media which metallic means is completely surrounded by fluorocarbon resin material.

The method of making a filter element of fluorocarbon resin which includes heat sealing the end edges of a filter media and thereafter bonding the end edges to end caps by preferentially melting fluorocarbon material positioned adjacent a metallic means encapsulated in said element.

75 **Description of the drawings**
Figure 1 is a composite isometric view, partially broken away, illustrating a filter element constructed in accordance with the principles of the present invention;

80 Figure 2 is a schematic diagram illustrating one of the steps in the manufacture of the filter element;

85 Figure 3 is a schematic diagram of a fragmented portion of the filter media after the step illustrated in Figure 2 has been performed;

90 Figure 4 is a schematic diagram of an additional step in the fabrication of a filter element constructed in accordance with the present invention;

95 Figures 5 and 6 are illustrative of a portion of the structure as shown in Figure 4;

100 Figure 7 is illustrative of an alternative embodiment as shown in Figures 5 and 6;

105 Figure 8 is an alternative embodiment showing an end portion of the filter media which may alternatively be used in a filter element constructed in accordance with the present invention; and

110 Figures 9 and 10 illustrate a manner of seaming the side edge of a filter media constructed in accordance with the present invention.

Detailed description of the invention

By utilization of a filter element constructed such that all of the surfaces exposed to the filtrant are constructed of a fluorocarbon resin almost unlimited life can be obtained from filter elements even in highly aggressive and hostile environments which normally limit the life of such filter elements. Such a filter element is illustrated in Figure

115 1 and is constructed in accordance with the principles of the present invention. As is therein shown a perforate support core 10 is constructed of a fluorocarbon resin and is utilized to support the filter media shown generally at 12. The filter media

120 12 is constructed of a filter membrane 14 which is laminated with a support screen 16. As an alternative embodiment an additional support screen 15 may be placed on the opposite side of the membrane 14 to assist in handling the membrane during processing steps to form the pleated media.

The membrane 14 is typically constructed of an expanded amorphous-locked fluorocarbon resin, such for example, be of the type as disclosed in U.S. Patent 3,953,566 which is incorporated herein by reference. In any event the membrane fluorocarbon resin 14 is of uniform porosity and separates very small particles from the filtrant and, for example, has a rating of from .1 to 10 microns. On the other hand, the screen 16, as well as the screen 15 (if used), merely provide a mechanical support for

- the membrane 14 and have relatively large pores therein which do not inhibit the flow of the filtrant.
- The filter media 12 is secured between a pair of end caps 18 and 20 one or both of which may have 5 an opening such as shown at 22 to provide for the flow of the filtrant which typically flows from outside in as is well known to those skilled in the art. The filter media 12 must be firmly secured to the end caps 18 and 20 in such a manner that a fluid 10 tight seal of high strength is obtained to prevent any leakage of the material being filtered. As is shown in Figure 1 the filter media 12 typically is pleated prior to being bonded to the end caps 18 and 20 but such is not required.
- 15 An outer protective sleeve 24 constructed of a perforate fluorocarbon resin is positioned over the filter media 12 to protect it from damage both from handling and also in the event a back pressure occurs from backflushing or an accidental surge or 20 the like. If desired, the outer sleeve may be eliminated.

As can be seen by those skilled in the art, the filter element as illustrated in Figure 1 has all surfaces thereof which have any opportunity to 25 contact the material being filtered constructed of a fluorocarbon resin. As a result thereof, the filter element can withstand attacks by highly reactive chemical materials of the type above referred to.

One of the major difficulties encountered in attempting to construct a filter element of all fluorocarbon resins has been forming the longitudinal seam on the media 12 and bonding of the fluorocarbon resin filter media 12 to the fluorocarbon resin end caps 18 and 20. Applicants have found 30 that by utilizing the laminated material as above described and by choosing a screen material 16 having a slightly lower melting point than the membrane material 14 and then by subjecting the end edges of the media 12 to appropriate heat and 35 pressure of sufficient magnitude to melt selectively the end edge of the screen portion 16 it will flow through the pores of the membrane 14 and effectively encapsulate the same. Such as illustrated schematically in Figure 2 to which reference is her- 40 eby made.

Preferably the membrane 14 is constructed of a polytetrafluoroethylene fluorocarbon resin (PTFE) which has been laminated to a screen 16 constructed of tetrafluoroethylene and hexafluoropropylene fluorocarbon resins (FEP). By placing the 45 end edge 26 of the media 12 between the surfaces of an anvil member 28 which is heated as is shown by the arrows 30 and by applying appropriate pressure as is illustrated by the arrow 32, the FEP melts and flows through the pores of the PTFE membrane as is shown in Figure 3 at 34. It has been found that if the temperature is maintained 50 between 545°F (285°C) to 560°F (293.3°C) at a pressure of approximately 200 p.s.i. (1.38 × 10⁶ Pas- 55 cals) for a period of approximately 5 seconds the appropriate melting and flow of the FEP material through the pores of the PTFE material occurs.

As is well known to those skilled in the art and as above referred to, the filter media is appropriately pleated and an edge thereof is seamed which

is further illustrated in Figures 9 and 10. As is shown, the edge 36 of the pleated media has been seamed to provide a seal along the entire length of the filter media. Through utilizing the technique as shown with regard to the end edges, particularly in Figures 2 and 3, it has been found that an appropriate seam which is totally sealed through the entire length of the filter may be accomplished.

Alternatively, as is illustrated in Figure 10 the side edges 38 and 40 of the material may have an additional layer 42 of FEP material placed therebetween. This sandwich is then subjected to the heat and pressure at the temperatures and for the times above designated which will result in an appropriate fluid tight sealing of the seam formed when the pleated media is placed into a cylindrical form as shown in Figure 9.

After the appropriate heat sealing of the end edges and the seam as above described the end edges are appropriately secured and bonded to each of the end caps 18 and 20.

For purposes of illustration an end cap 18 is shown in cross section in Figure 4 with the filter media 12 positioned in place therein during the bonding step required for construction of a filter element in accordance with the present invention. As is shown in Figure 4 the end cap 18 is preferably constructed of FEP fluorocarbon resin material. The end cap is basically cup-shaped as is illustrated in Figure 4 and as also shown in Figure 1 may if desired have a centrally disposed opening as shown at 22.

Within the cup there is positioned a metallic means 44 which is totally surrounded by a fluorocarbon resin 46 preferably in accordance with the preferred embodiment of the present invention FEP. It should be noted that metallic member 44 is disc shaped and preferably is perforate in that a plurality of openings 48 are provided therein to provide a free flow of the FEP material 46 therethrough. The metallic means need not be perforate and in certain instances may preferably be a solid member.

By application of energy preferably through an inductance heating apparatus as is illustrated by the arrows 50 to the end cap 18 the metallic means such as the disc 44 preferentially absorbs heat as compared to the surrounding fluorocarbon material and thus melts the adjacent FEP. When the FEP material 46 is melted the end edges of the filter media 12, which would have appropriately been heat sealed and have the configuration as shown in Figure 3 are pressed into the molten FEP material in the end cap. When the end edges are submerged in the molten FEP, the FEP material at the end edges, as shown at 34 in Figure 3, again melts and becomes intimately mixed with the molten FEP 46 in the bottom of the end cap 18. Thereafter the heat is removed and the combination permitted to cool. Obviously if such is desired appropriate forced cooling can be employed although such is not necessary in accordance with the principles of the present invention. By this process the FEP penetrates the pores in the PTFE membrane and completely surrounds or encapsulates the end

edges of the membrane. Such encapsulation provides a secure bond which will withstand attacks from hostile filtrants and prevent leakage.

The structure as shown in Figure 4 may be realized by inserting into the bottom portion of the end cap 18 particles of FEP which may take any form desired such as powdered, granular, sheet or the like. The only requirement is that there is intimate contact between such material and the metallic means 44 to accomplish the desired preferential melting of the material adjacent the metallic means 44. Alternatively as is shown in Figures 5 and 6 the metallic member may be washer shaped as is illustrated at 52 and may have a coating 54 of the FEP material formed thereon prior to its being placed in the bottom of the end cap 18.

As is shown in Figure 7 a further alternative embodiment includes a plurality of particles 56 of metallic material each of which is coated as shown at 58 by a fluorocarbon resin material such as FEP. The metallic particles can be placed in the bottom of the end cap 18 and upon the application of the heat 50 thereto will again preferentially melt the FEP to provide the bonding of the end edges of the filter media 12 to the end cap.

If desired, to assist in bonding the end edges of the filter media to the end caps, an additional amount of FEP can be provided at the end edges of the filter media by the technique which is shown in Figure 8. As is therein illustrated, upon application of the heat and pressure as provided and discussed with regard to Figure 2 an additional extension of the FEP screen 16 can be provided as shown at 58 so that it extends beneath or beyond the membrane PTFE member. Upon application of heat and pressure the FEP screen is melted and becomes imperforate as shown at 58. Upon this extension being inserted into the molten FEP in the end cap after the application of the heat as shown in Figure 4, the extension of the FEP material is provided to enhance the bonding of the end edges of the filter media to the end caps as above described.

It will also be recognized by those skilled in the art and particularly with reference to Figure 1 that at the same time the filter media 12 is bonded to the end caps the support tube 10 and the protective sleeve 24 may also be bonded to the end caps in like manner. It will also, however, be recognized that there is no necessity for such bonding to occur since the support tube and the protective sleeve only provide a mechanical support and protection for the filter media 12 and need not be bonded. The only requirement is that the filter media 12 be securely and permanently bonded to the end caps to preclude any possibility of leakage of the material being filtered thereby contaminating the filtrant.

60 CLAIMS

1. A filter element in which all exposed surfaces are constructed of a fluorocarbon resin comprising:

65 (A) a fluorocarbon resin perforate support core

member;

(B) a fluorocarbon resin filter media including a porous membrane disposed upon said support core member and having first and second end edges;

(C) first and second fluorocarbon resin end caps bonded to said first and second end edges, respectively; and

(D) metallic means embedded within each of said end caps adjacent said end edges and completely surrounded by fluorocarbon resin material.

70 2. The filter element as defined in claim 1 wherein said filter media includes a plurality of layers of fluorocarbon resin material and wherein said end edges of said media are first heat sealed prior to bonding said end caps to said media.

75 3. The filter element as defined in claim 1 wherein each of said metallic means is a perforate metallic disc.

80 4. The filter element as defined in claim 3 wherein each said disc is coated with a fluorocarbon resin material before being inserted into said end caps.

85 5. The filter element as defined in claim 3 wherein said perforate metallic disc is washer shaped.

90 6. The filter element as defined in claim 5 wherein each said washer is coated with a fluorocarbon resin material before being inserted into said end cap.

95 7. The filter element as defined in claim 1 wherein said metallic means includes a plurality of metallic granules dispersed within each said end cap.

100 8. The filter element as defined in claim 7 wherein each said granule is coated with a fluorocarbon resin material before being inserted into said end cap.

105 9. The filter element as defined in claim 1 which further includes an outer fluorocarbon resin perforate protective sleeve disposed over said filter media.

110 10. The filter element as defined in claim 9 wherein said inner support core and said protective sleeve are bonded to each of said end caps.

115 11. The filter element as defined in claim 2 wherein said media includes a screen of fluorocarbon resin material laminated with said membrane fluorocarbon resin member.

120 12. The filter element as defined in claim 11 wherein said screen extends through pores in said membrane along said heat sealed end edges.

130 13. The filter element as defined in claim 2 wherein said filter media is pleated.

125 14. The filter element as defined in claim 13 wherein said media includes a membrane fluorocarbon resin member laminated with a screen of fluorocarbon resin material which is heat sealed along said end edges and along adjacent side edges so that a portion of said screen extends through pores in said membrane along said heat sealed edges.

15. The filter element as defined in claim 11 wherein said screen material has a melting point which is lower than the melting point of said mem-

brane material.

16. The filter element as defined in claim 15 wherein a portion of said screen material extends through pores in said membrane material along 5 said end edges thereof.

17. The filter element as defined in claim 16 wherein said end caps and said screen material are constructed of the same fluorocarbon.

18. The filter element as defined in claim 16 10 which is cylindrical in shape and which further includes a side edge which is heat sealed and wherein said screen material extends through pores in said membrane material.

19. The filter element as defined in claim 18 15 which further includes an additional layer of fluorocarbon resin material coterminous with said side edge and at least a portion of which extends through said pores of said membrane material, said additional layer being of the same material as 20 said screen.

20. The method of manufacturing a filter element constructed of fluorocarbon resin and housing a filter media bonded at its opposite end edges to a pair of end caps, said media having a laminated screen and porous membrane, said method 25 comprising the steps of:

(A) applying heat and pressure to the end edges of said laminate filter media for a time and at a temperature sufficient to melt said screen and 30 to allow said molten screen material to flow through the pores of said membrane;

(B) placing a metallic means surrounded by a fluorocarbon resin in at least one of said end caps;

(C) applying heat to said end cap and said metallic means for a time and at a temperature sufficient to preferentially melt said fluorocarbon resin surrounding said metallic means;

(D) inserting said end edges of said filter media into said molten fluorocarbon material; and

40 (E) cooling said end cap to solidify said molten material and bond said laminate filter media to said end cap.

21. The method as defined in claim 20 which further indicates the steps of pleating said filter 45 media forming said media into a cylinder, and applying heat and pressure to the contiguous side edges of said cylinder for a time and at a temperature to melt said screen and allow it to flow through pores in said membrane before bonding 50 said media to said end caps.

22. A filter element, substantially as herein described with reference to the accompanying drawings.

23. A method of manufacturing a filter element, 55 substantially as herein described with reference to the accompanying drawings.